Module 8
Wire Rope Construction & Selection

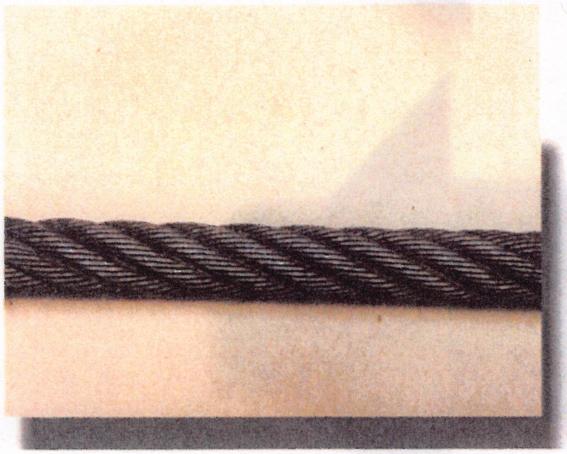
Learning Objectives

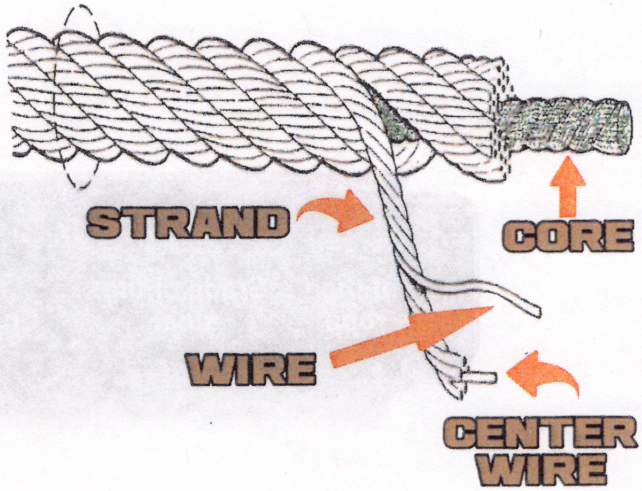
By the end of this section, you will:

1. Know the terminology and construction configurations of wire rope.
2. Identify the abbreviations on a wire rope tag.
3. Understand the wire rope requirements of 1926.1414.
4. Distinguish between regular lay and lang lay.
5. Compare the advantages of right lay to left lay.
6. Know the relationship between working load limit (WLL) and breaking strength.
7. Understand the causes of wire rope corrosion and ways to prevent them.

Wire rope is made from steel wires laid together to create a strand.

Strands are wound together to form a rope, usually around a central core of either fiber or wire.

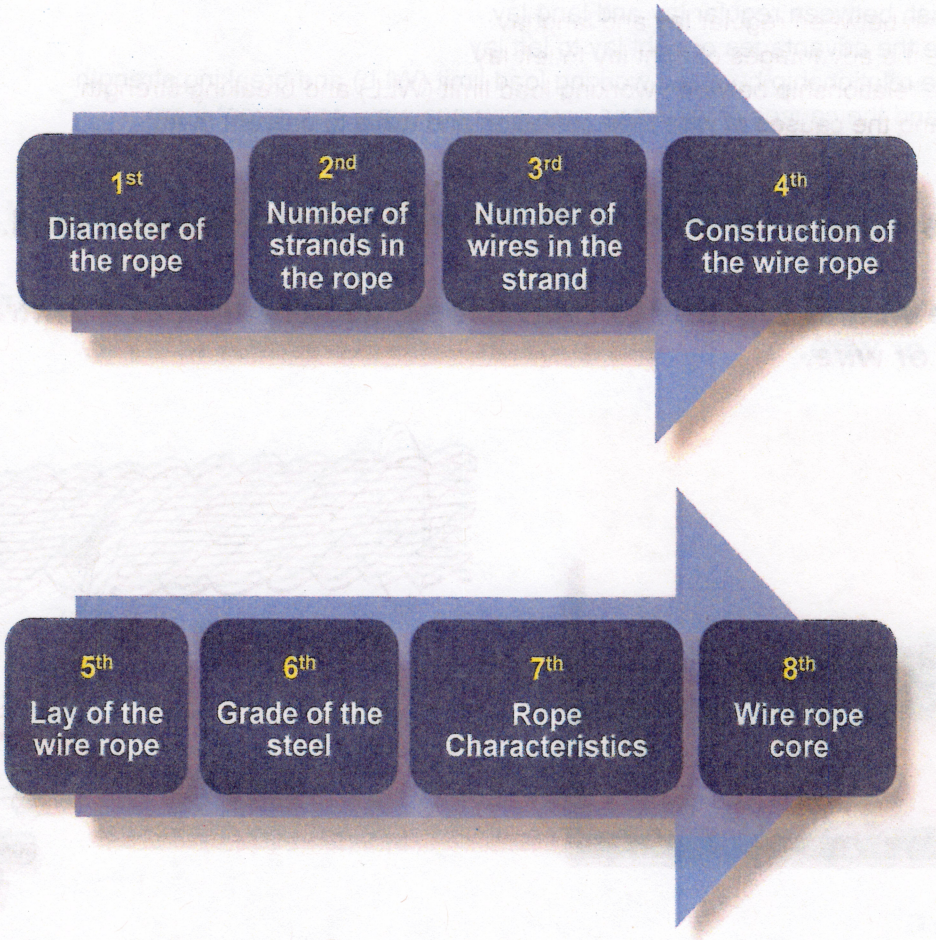




Design affects strength, flexibility and resistance of wire rope.

Strength	• Size • Grade of wire • Core type
Flexibility	• Wires in strand • Rope lay
Abrasion resistance	• Wires in strand • Rope lay
Crushing resistance	• Core • Wires

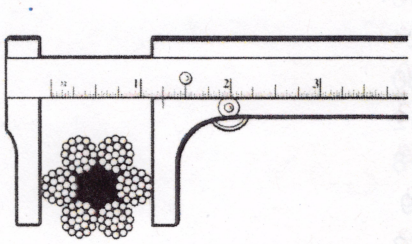
Wire rope is identified with the following information in the following order:



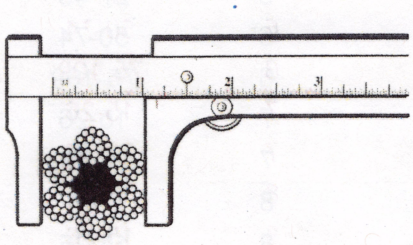
Diameter of Rope

Wire rope diameter is measured at the widest point with dial or vernier calipers.

The diameter of a wire rope is the diameter of the smallest circle which will enclose all the strands. When measuring wire rope, take 3 measurements on a 6 strand rope and 4 measurements on an 8 strand rope.



Correct



Incorrect

Reduction of diameter may be a sign of potential damage to the core of the wire rope.

Number of Strands

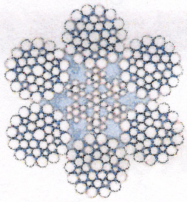
Most wire rope is made from preformed strands to provide better load distribution and prevent unraveling.

More wires per strand

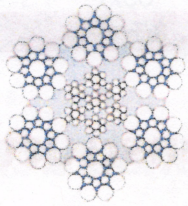
- Smaller wires
- Easier to bend
- More susceptible to wear

Fewer wires per strand

- Larger wires
- Hard to bend
- Less susceptible to wear



6 x 37



6 x 19

Which wire rope is the most flexible?

1. 6x7 ☐
2. 6x19 ☐
3. 6x26 ☐
4. 6x37 ☑

"6x26 wire rope" means there are:

» 6 strands with 26 wires per strand.

Wire Rope Classifications

Based on the Normal Number of Wires in a Strand:

Classification	Outer Strands	Wires/ Strands	Maximum No. Outer Wires
6x7	6	3-14	9
6x19	6	15-26	12
6x37	6	27-49	18
6x61	6	50-74	24
6x91	6	75-109	30
7x19	7	15-26	12
7x37	7	27-49	18
8x7	8	3-14	9
8x19	8	15-26	12
8x37	8	27-49	18
8x61	8	50-74	24

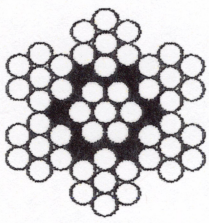
Rotation Resistant Ropes:

Classification	Total Strands	Wires/ Strands	Maximum No. Outer Strands
8x19	15	15-26	12
19x7	17-19	6-9	8
19x19	17-19	15-26	12
35x7	26-36	6-9	8
35x19	26-36	15-26	12

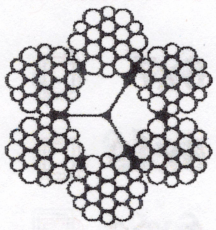
Construction of Rope

Wire rope designs must be chosen carefully.

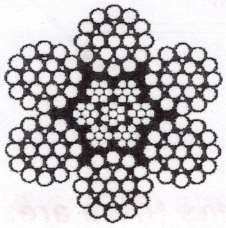
Wire rope is designed and constructed in a number of configurations including, but not limited to, ordinary, warrington, filler and seale.



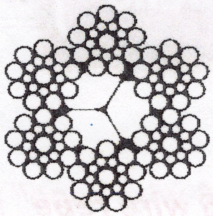
Ordinary



Warrington



Filler



Seale

Seale wire rope is typically used as haulage rope, rigging rope and rotary drilling line.

Seale Characteristics:

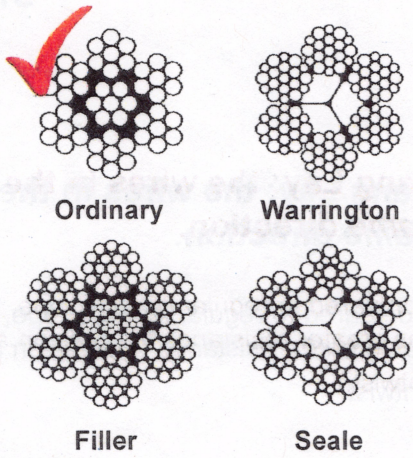
- Resistant to abrasion and crushing;
- Medium fatigue resistance.

Filler wire rope is typically used for pull ropes, load lines, backhaul ropes and draglines.

Filler Characteristics:

- Less abrasion resistance;
- More bending fatigue resistance.

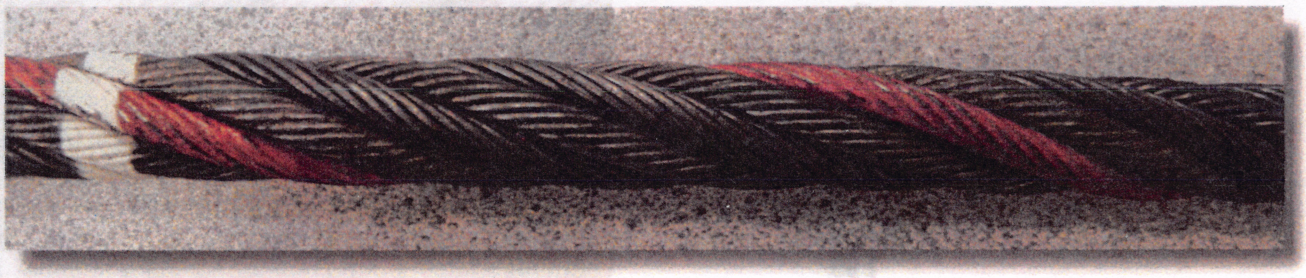
Which rope is better for abrasion?



Lay of the Wire Rope

Lay refers to the direction of winding of the wires in the strand and the strands in the wire rope.

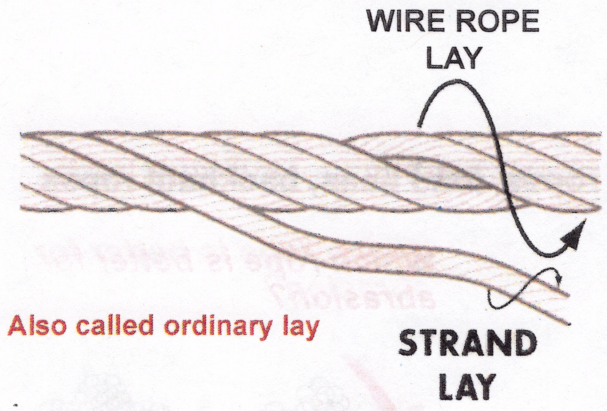
There are four lay types: regular, lang, alternating and herringbone. Wire rope lay types will come in both right hand and left hand lay.

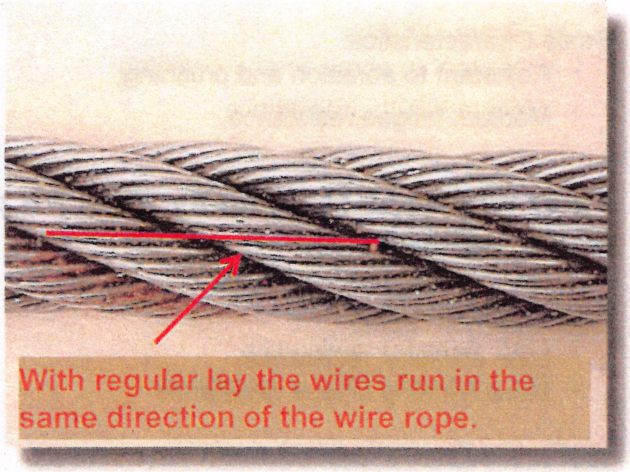


Regular lay - the strands and the wires wrapped around the strands are laid in opposite directions.

Regular lay wire rope is more stable when loaded.

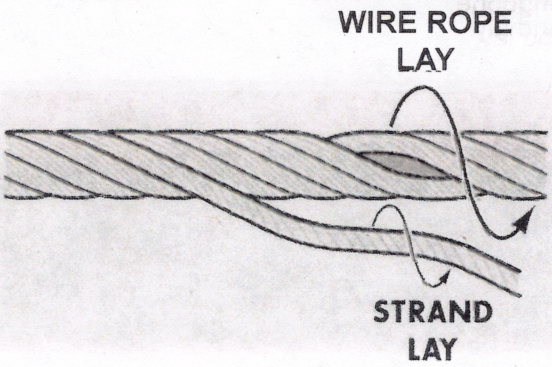
Compared to lang lay wire rope, regular lay is less likely to kink and untwist, easier to handle, more crush resistant. Most wire rope slings use regular lay.





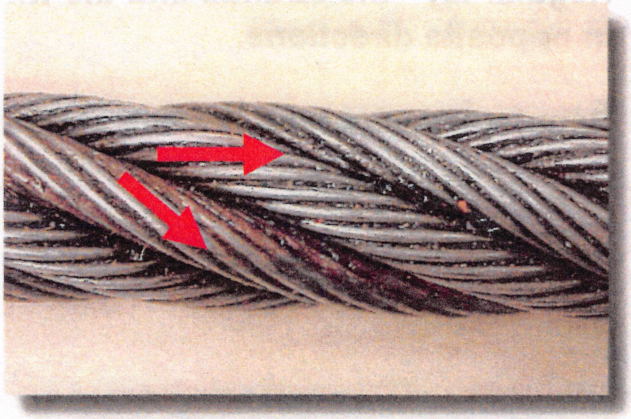
Lang Lay: the wires in the strand and the strands in the wire rope are laid in *same* direction.

Compared to regular lay wire rope, lang lay wire rope is less stable when loaded but more flexible and has greater resistance to abrasion and fatigue resistance. Lang lay wire rope is more likely to kink and untwist.

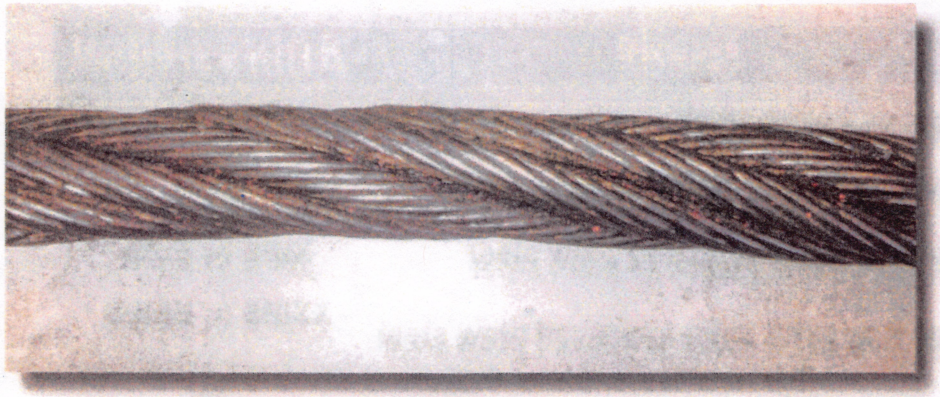


Alternating lay ropes have alternating strands of regular and lang lay.

They combine the best features of regular and lang lay for boom hoist or winch lines.



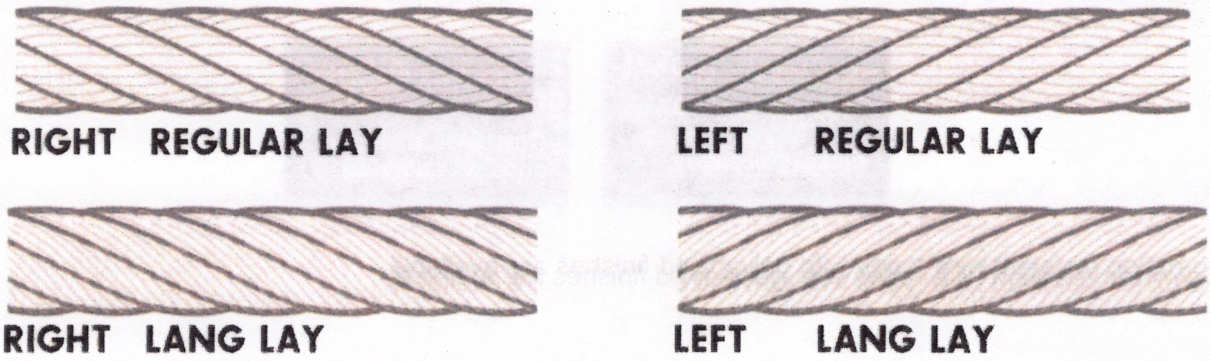
Herringbone is a 6-strand wire rope comprised of four Lang and two regular lay strands. The Lang lay strands are arranged in pairs, with each pair of Lang lay alternating with one strand of regular lay.



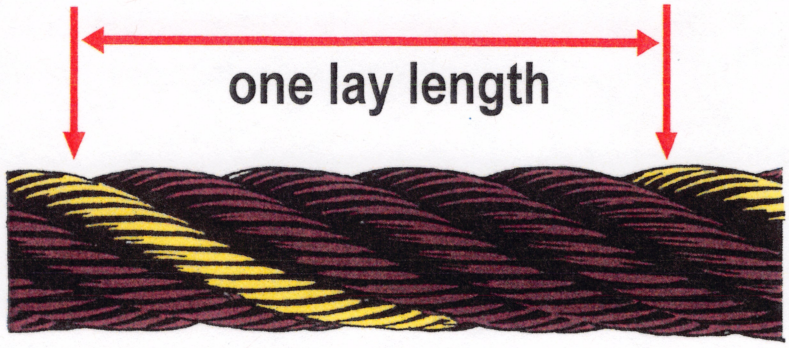
With right lay, strands are wound around the core in a clockwise direction.

With left lay, strands are wound around the core in a counterclockwise direction.

Right lay is the most common in construction. Left lay is used in a few special situations – cable tool drilling line, for example.



Lay length is the distance measured along a wire rope in which a strand makes one complete revolution.



Grade of the Steel and Special Characteristics

Wire rope grades are often abbreviated.

Grade	Abbreviation
Improved plow steel	IPS
Special improved plow steel	SIPS
Type I or extra improved plow steel	XIPS or EIPS *
Type II or extra extra improved plow steel	XXIPS or EEIPS *
Traction steel	TS
Plow steel	PS
Mild plow steel	MPS

*Extra is sometimes designated with an X

Corrosion often starts inside the rope and is usually caused by a lack of lubrication.

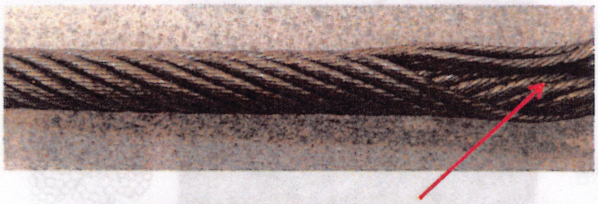
Chromium-Nickel
- Typically type 302 or type 305 chromium-nickel steel alloy

Phosphor Bronze and Copper Wires
- Corrosion resistant and non-sparking

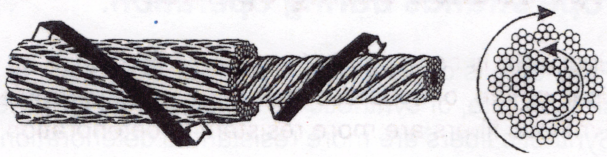
Corrosion resistant wire ropes with galvanized finishes are available.

Non-rotating or rotation resistant wire rope is available.

Rotation resistant wire rope is not for use on boom hoist systems and manufacturer's directions for use of swivels must be followed. Rotation resistant rope has higher safety factors but damage is harder to find. If you are using non-rotating wire rope, consult the manufacturer regarding the use of multi-part reeving or swivels for end terminations.



Core strands wrap in the opposite direction of outer strands.



Review the three types and their requirements for use in 1926.1414(d) & (e)

Rotation resistant ropes are a special category of wire rope designed to resist the tendency to spin or rotate under load. The most common rotation resistant rope has outside strands laid to the right and inside strands laid to the left. As one layer of strands attempts to rotate in one direction, it is counteracted by the other layer acting in the opposite direction. The ropes are not perfectly non-rotating. When a load is applied they will rotate to a degree (when lifting on a single part line). This rotation is due to the fact that there is more "torque" in the outer layer of strands than there is in the inner layer. As the outer strands unwind (and become longer), the inner strands wind up tight (and become shorter). The shorter of the two layers (the inner) will carry more load. The inner layer often uses the "stretchiness" and increased rotation afforded by a Lang lay to help equalize the loading between inner and outer layers. This extra loading plus the very high stresses created at the points where the two layers of strands are in contact causes wire fatigue which in time results in broken wires in the inner layer of strands.

Rotation resistant wire ropes need to be inspected carefully because they wear from inside out.

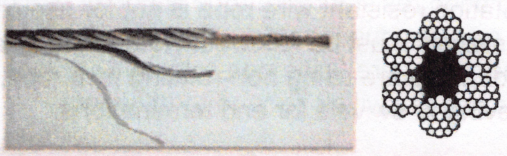
Inspect rotation resistant (non-rotating, non-spin, spin-resistant) wire rope very carefully because they tend to wear from the inside out. Before little if any damage or wear is evident on the outside of the rope they can be severely damaged inside. An easy way to check is to hold the wire rope close to your ear and bend along the length, running the bend back and forth. If you hear a crackling or popping sound there are probably broken wires inside.

In most manuals and safety regulations the guidelines for removal from service don't go far enough as they ignore the heavy internal wear found in these ropes. Because of the design characteristics of these ropes, care must be taken to avoid excessive loads over small diameter sheaves. Some rotation resistant wire ropes are recommended to be reeved only as single part lines to extend their service life.

Conducting a listening test

Wire Core

There are three types of wire rope core: fiber core, wire strand core and independent wire rope core.



Fiber core

Fiber cores provide a cushion for wire rope strands during operation.

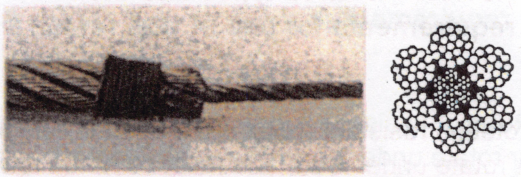
Fiber core is composed of vegetable fiber such as manila, sisal, or jute, or synthetic fiber such as polypropylene. Synthetic fibers are more resistant to deterioration.

Fiber core is saturated with a lubricant when it is fabricated. Lubricant is released during use keeping the wire lubricated.

Wire strand core

Wire core has advantages over fiber core.

- Adds 7-1/2% in strength.
- More resistant to crushing.
- Does not burn or char under extreme heat conditions.



Independent wire rope core

Independent wire rope core (IWRC) is small wire rope used as the core of wire rope.

Consists of a 6 x 7 strand steel wire rope with a 7 wire center strand. This core finds greatest use where ropes are subjected to severe pressure while running over sheaves or winding onto drums. This type of core should be used when a rope operates in temperatures damaging to natural or man-made fibres. It provides additional strength and less stretch.

Breaking strength is the strength that the wire rope is tested at by the manufacturer.

This is the minimum amount of force that is put on a wire rope before it breaks. Because manufacturers differ, results will vary.